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**Patentanmeldung Nr. Patent application No. Demande de brevet n°**

02016089.1

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Process to generate heat

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# Process to generate heat

The invention is directed to a process to generate heat by burning a liquid fuel in an evaporator burner oven.

Processes to generate heat in domestic applications are known, wherein kerosene is used as fuel in evaporator burner ovens. Examples of such ovens are supplied by Jotul ASA Norway and AGA Foodservices Group plc. The ovens are technically simple and often require no additional moving parts to operate. For example the fuel may be supplied to the oven by means of gravity wherein the fuel tank is positioned at a somewhat elevated position relative to the oven itself. If the tank is empty the user will typically have to refill the tank by hand. This method of generating heat, for example to provide domestic heating or household cooking, is very popular in regions which are not provided with a natural gas supply means. The fuel most often used is kerosene.

A disadvantage of the use of such ovens is that they sometimes fail to function due to coke deposits inside the oven. Coke deposits may form at the bottom plate of the burner when operating at a low power demand. Especially when such ovens are used for domestic heating during long and strong winters such breakdown is not favored.

The object of the present invention is to provide a process wherein the reliability and efficiency of the evaporator burner oven is improved. Additionally, emissions are reduced and health and safety issues are therefore improved.

This object is achieved with the following process. Process to generate heat by burning a liquid fuel in an evaporator burner oven, wherein the liquid fuel comprises a Fischer-Tropsch derived fuel.

Applicants found that when a Fischer-Tropsch derived fuel is used less carbon deposits tend to form. It is found that the Smoke Number, which is correlated with the amount of carbon deposits, is significantly lower when a Fischer-Tropsch derived fuel is used. Because of the lower carbon deposits less failure of the oven will result. Furthermore a decrease in soot deposits will also be beneficial for achieving a better heat transfer, teherby maintaining a high efficiency of the oven over a prolonged period of time. An additional advantage is that this fuel has no significant odour. The traditionally used kerosene fuel normally has a strong smell and any spills of kerosene on clothing and ground while filling the tank will be smelled for a prolonged time. By using the Fischer-Tropsch derived fuel a much more consumer friendly process is obtained. Applicants have further found that the carbon monoxide emissions and the unburned hydrocarbon emissions are significantly lower when using the Fischer-Tropsch derived fuel when compared to the traditional kerosene fuel.

A further advantage is that this process is an attractive alternative to wood burning, which fuel is still often used for household cooking in less developed regions around the world.

Finally the Fischer-Tropsch derived fuel is biodegradable. Thus any spills or leaking tank vessels will not effect the environment as would be the situation when a petroleum derived kerosene is used.

The evaporator burner oven, which may be used in the process of the present invention, may be any oven known to one skilled in the art, which operates, by combustion

of evaporating liquid fuel with an oxygen containing gas. In such ovens the fuel is supplied to a surface wherein it evaporates into a space surrounding said surface and wherein the evaporated fuel is combusted with oxygen containing gas supplied to said space. Such a surface may be a wick or the exterior of fuel supply conduits which conduits are provided with openings to discharge said fuel from the interior to said exterior surface. Such evaporating burner ovens are for example described in general textbook "Heizung + Klimatechnik 01/02" German Version by Recknagel, Sprenger, Schramek, ISBN: 3-468-26450-8 on page 718. Examples of such evaporator burner ovens are the so-called Forced Air Type Open Oil Heater, Natural Draft Open Wick Type Oil Heater, the ovens as manufactured by Jotul from Norway, as for example the Jotul 709 Oven, the well known AGA cooker as manufactured by the Aga Foodservice Group plc and similar ovens of other suppliers such as for example Windhager, Schraak, Haas & Sohn or Buderus.

The evaporating burner oven should be distinguished from burners which first atomise the fuel into small droplets and wherein the combustion takes place on the surface of the resulting small liquid droplets or takes place on the evaporated mixture of fuel and gas.

The Fischer-Tropsch derived fuel will comprise a Fischer-Tropsch product which may be any fraction of the middle distillate fuel range, which can be isolated from the (hydrocracked) Fischer-Tropsch synthesis product. Typical fractions will boil in the naphtha, kerosene or gas oil range. Preferably a Fischer-Tropsch product boiling in the kerosene or gas oil range is used because these fractions are easier to handle in for example domestic environments. Such products will suitably comprise a fraction larger than 90 wt% which boils

between 160 and 400 °C, preferably to about 370 °C. Examples of Fischer-Tropsch derived kerosene and gas oils are described in EP-A-583836, WO-A-9714768, WO-A-9714769, WO-A-011116, WO-A-011117, WO-A-0183406, WO-A-0183648, WO-A-0183647, WO-A-0183641, WO-A-0020535, WO-A-0020534, EP-A-1101813, US-A-5766274, US-A-5378348, US-A-5888376 and US-A-6204426.

The Fischer-Tropsch derived product will suitably contain more than 80 wt% iso and normal paraffins and less than 1 wt% aromatics, the balance being naphthenics compounds. The content of sulphur and nitrogen will be very low and normally below the detection limits for such compounds. This low content of these elements is due to the specific process wherein the Fischer-Tropsch reaction is performed. The content of sulphur will therefore be below 5 ppm and the content of nitrogen will be below 1 ppm. As a result of the low contents of aromatics and naphthenics compounds the density of the Fischer-Tropsch product will be lower than the conventional mineral derived fuels. The density will be between 0.65 and 0.8 g/cm$^3$ at 15 °C.

The fuel used in the process of the present invention may also comprise fuel fractions other than the Fischer-Tropsch derived fuel product. Examples of such components may be the kerosene or gas oil fractions as obtained in traditional refinery processes, which upgrade crude petroleum feedstock to useful products. Preferred non-Fischer-Tropsch fuel fractions are the ultra low sulphur (e.g. less than 50 ppm sulphur) kerosene or diesel fractions, which are currently on the market. Optionally non-mineral oil based fuels, such as bio fuels, may also be present in the fuel composition. The content of the Fischer-Tropsch derived product in the fuel will be preferably be above 40 wt%, more preferably above 60 wt% and most preferably above 80 wt%. It should

be understood that the content of such, currently less available, Fischer-Tropsch derived products will be optimised, wherein pricing of the total fuel will be balanced with the advantages of the present invention. For some applications fuels fully based on a Fischer-Tropsch derived product plus optionally some additives may be advantageously used.

Evaporator burners are often provided with a flame detector. Most detectors, which are used today, detect a particular wavelength associated with the yellow colour of the flame. Applicants have now found that when a Fischer-Tropsch derived fuel is used the commonly known detectors fail to observe the resulting blue coloured flame. For this reason the evaporator burner is preferably provided with a detector, which can detect this blue flame. Examples of suitable detectors are the detectors that are used in so-called blue flame burners. Alternatively additives may be added to the Fischer-Tropsch derived fuel which result in a flame which can be detected by the above standard evaporator burner detector.

The fuel may also comprise one or more of the following additives. Detergents, for example OMA 350 as obtained from Octel OY; stabilizers, for example Keropon ES 3500 as obtained from BASF Aktiengesellchaft, FOA 528A as obtained from OCTEL OY; metal-deactivators, for example IRGAMET 30 (as obtained from Speciality Chemicals Inc; (ashless) dispersants, for example as included in the FOA 528 A package as obtained from Octel OY; anti-oxidants; IRGANOX L57 as obtained from Specialtiy Chemicals Inc; cold flow improvers, for example Keroflux 3283 as obtained from BASF Aktiengesellschaft, R433 or R474 as obtained from Infineum UK Ltd; combustion improver, for example ferrocene, methylcyclopentadienylmanganese-tricarbonyl

(MMT); anti-corrosion: Additin RC 4801 as obtained from Rhein Chemie GmbH, Kerocorr 3232 as obtained from BASF, SARKOSYL 0 as obtained from Ciba; re-odorants, for example Compensol as obtained from Haarman & Reiner; biocides, for example GROTA MAR 71 as obtained from Schuelke & Mayr; lubricity enhancers, for example OLI 9000 as obtained from Octel; dehazers, for example T-9318 from Petrolite; antistatic agents, for example Stadis 450 from Octel; and foam reducers, for example TEGO 2079 from Goldschmidt.

The Fischer-Tropsch derived product is colourless and odourless. For safety reasons an odour marker, as for example applied in natural gas for domestic consumption, may be present in the Fischer-Tropsch derived product. Also a colour marker may be present to distinguish the fuel from other non-Fischer-Tropsch derived product.

The total content of the additives may be suitably between 0 and 1 wt% and preferably below 0.5 wt%.

The invention will now be illustrated with the following non-limiting examples.

Example 1

To a Jotul 709 Oven (as manufactured by Jotul ASA in Norway) a Fischer-Tropsch derived kerosene having the properties as listed in Table 1 was operated in a period of 90 minutes. The feed rate was varied in time to simulate a practical domestic heating situation. The variation in feed rate was as listed in Table 2.

Table 1

| | Fischer-Tropsch kerosene | Reference oil: Norway Kero |
|---|---|---|
| Density (at 15 °C) | 734.8 | 810 |
| Kinematic viscosity at 20 °C (mm2/s) | 1.246 | Not Measured |
| Flash point (°C) | 43 | Not Measured |

Table 2

| Time period (seconds) | Feed rate SMDS Kero | Feed rate (kg/h) Norway Kero |
|---|---|---|
| 0 and 1800: middle load. | 0,2 | 0,15 |
| 1800 and 3600: maximum load. | 0,4 | 0,324 |
| 3600 and 5400: minimum load. | 0,14 | 0,092 |
| | | |

During the experiment the Smoke Number according to DIN 51402-1, the hydrocarbon content by means of photo ionization detector (FID) and the carbon monoxide content by infrared spectroscopy in the exhaust gases leaving the oven were measured. The results of these measurements are presented in Figures $1^a$ - $3^a$.

<u>Comparative experiment A</u>

Example 1 was repeated except that commercial petroleum derived kerosene was used of which the properties are listed in Table 1. The petroleum derived kerosene fuel used is currently used as fuel in evaporating burner ovens in Norway.
The results of these measurements are also presented in Figures $1^b$ - $3^b$.

As can be seen from Figures 1-3 is that the process according to the present invention results in a reduction of hydrocarbons and carbon monoxide in the exhaust of the oven. This is very advantageous because health, safety, environment and efficiency issues are improved.
Emissions that are harmful to human health are reduced

(soot and potential carcinogenic potential). Also CO danger of suffocation in case of leakages of exhaust gases into the room is reduced. A complete combustion, indicated by a lack of unburned hydrocarbons and low CO emissions, also increase efficiency. Decreased hydrocarbon emissions also decrease the danger of chimney burns. Less soot deposits also prevent the formation of films on the heat exchanger surface, which can decrease the heat transfer and therefore the resulting efficiency.

# C L A I M S

1. Process to generate heat by burning a liquid fuel in an evaporator burner oven, wherein the liquid fuel comprises a Fischer-Tropsch derived fuel.

2. Use according to claim 1, wherein the Fischer-Tropsch derived fuel boils for more than 90 wt% between 160 and 400 °C.

3. Use according to claim 2, wherein the Fischer-Tropsch derived fuel boils for more than 90 wt% between 160 and 370 °C.

4. Use according to any one of claims 1-3, wherein the Fischer-Tropsch derived fuel comprises a Fischer-Tropsch product which contains more than 80 wt% of iso and normal paraffins, less than 1 wt% aromatics, less than 5 ppm sulphur and less than 1 ppm nitrogen and wherein the density of the Fischer-Tropsch product is between 0.65 and 0.8 $g/cm^3$ at 15 °C.

5. Use according to any one of claims 1-4, wherein the Fischer-Tropsch derived fuel comprises more than 80 wt% of a Fischer-Tropsch product.

6. Use according to claim 5, wherein the Fischer-Tropsch derived fuel comprises a mineral oil fraction and/or a non-mineral oil fraction.

7. Use according to any one of claims 1-6, wherein the Fischer-Tropsch derived fuel comprises one or more additives.

8. Use according to claim 7, wherein the Fischer-Tropsch derived fuel comprises an odour marker.

9. Use according to any one of claims 7-8, wherein the Fischer-Tropsch derived fuel comprises a colour marker.

10. Use according to any one of claims 7-9, wherein an additive is present which changes the colour of the flame such that is detectable by a yellow flame detector.

11. Use according to any one of claim 1-9, wherein a blue flame detector is used to detect the flame of the evaporator burner.

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ABSTRACT

PROCESS TO GENERATE HEAT

Process to generate heat by burning a liquid fuel in an evaporator burner oven, wherein the liquid fuel comprises a Fischer-Tropsch derived fuel. The fuel boils for more than 90 wt% between 160 and 400 °C and comprises a Fischer-Tropsch product which contains more than 80 wt% of iso and normal paraffins, less than 1 wt% aromatics, less than 5 ppm sulphur and less than 1 ppm nitrogen and wherein the density of the Fischer-Tropsch derived product is between 0.65 and 0.8 $g/cm^3$ at 15 °C.

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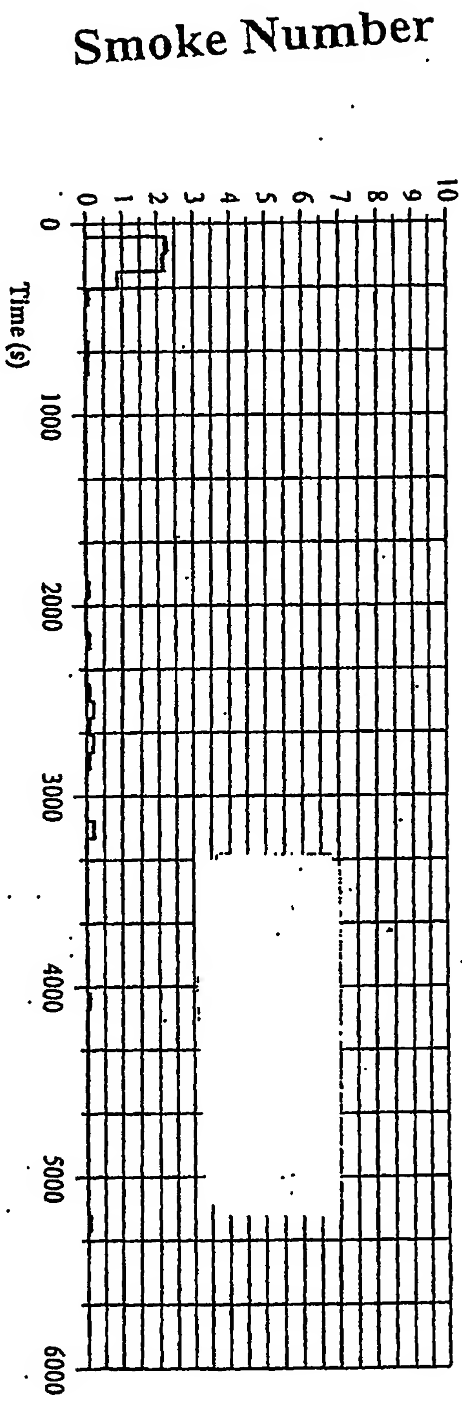


Fig. 1a

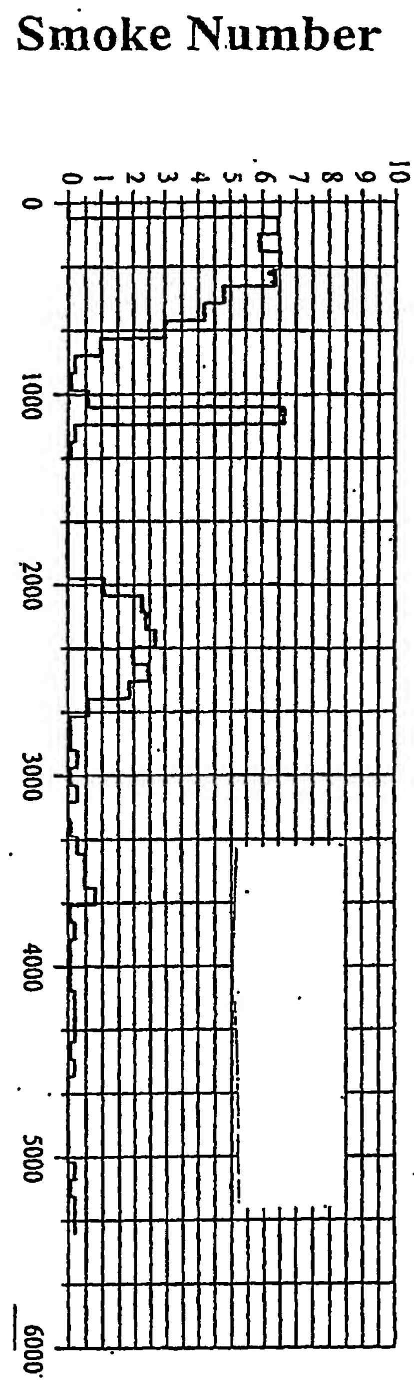


Fig. 1b

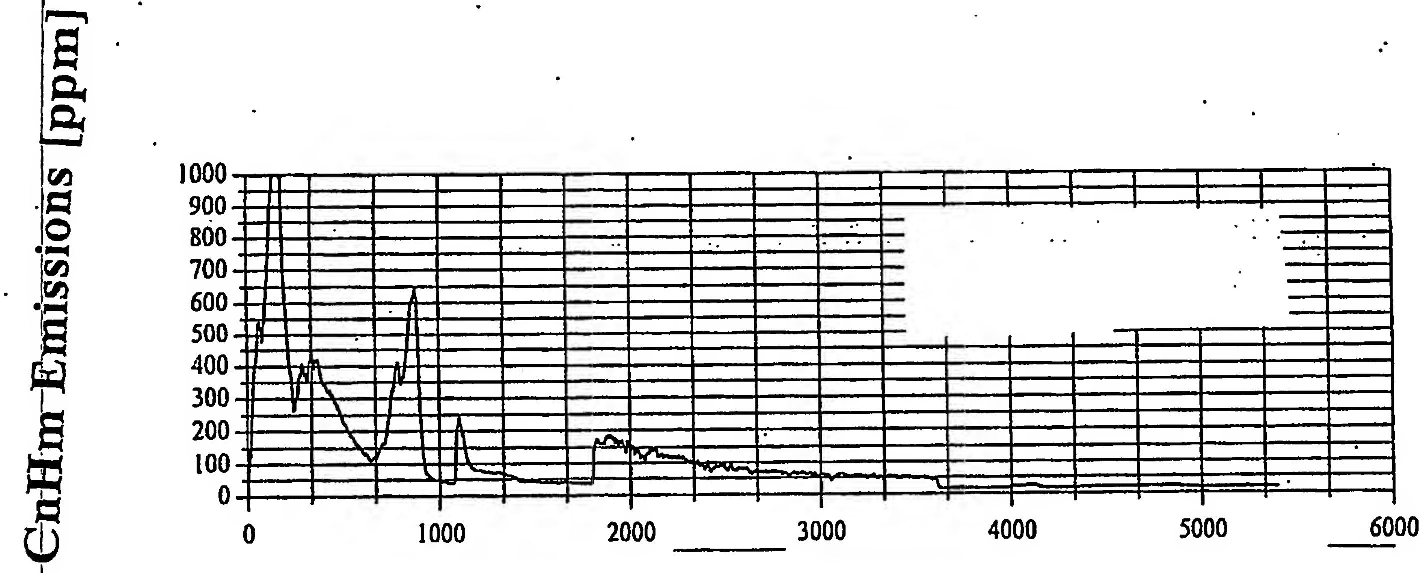
CnHm Emissions [ppm]
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
6000

Fig. 2b

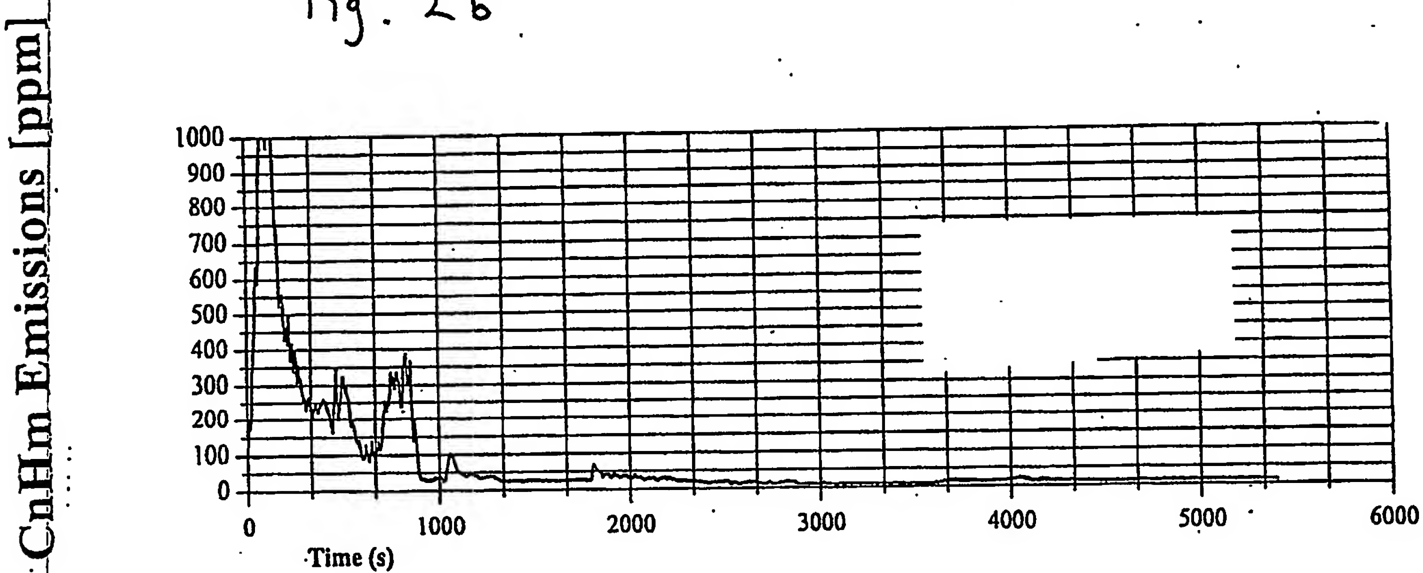
CnHm Emissions [ppm]
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
6000
Time (s)

Fig. 2a

## CO Emissions [ppm]

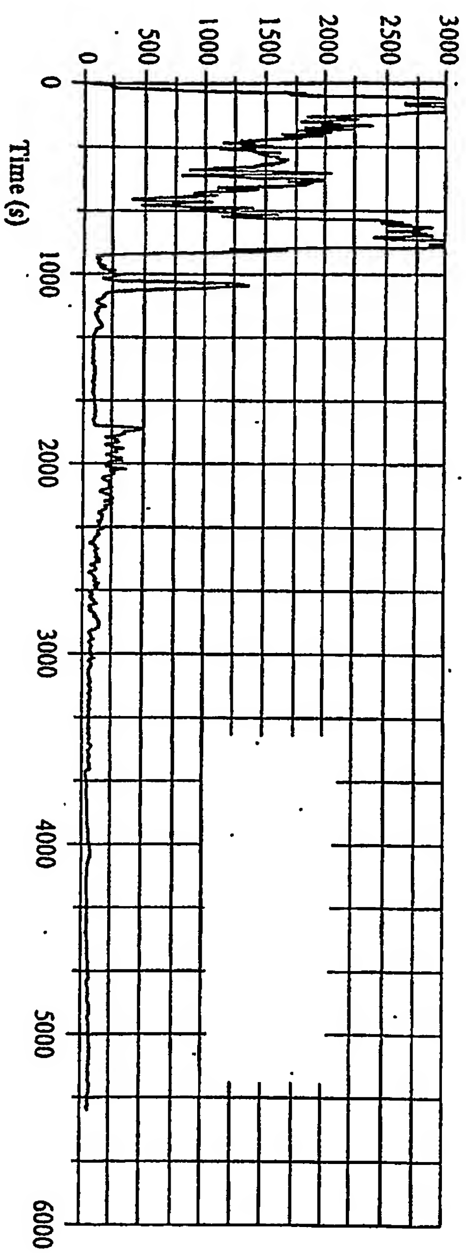


Fig. 3a

## CO Emissions [ppm]

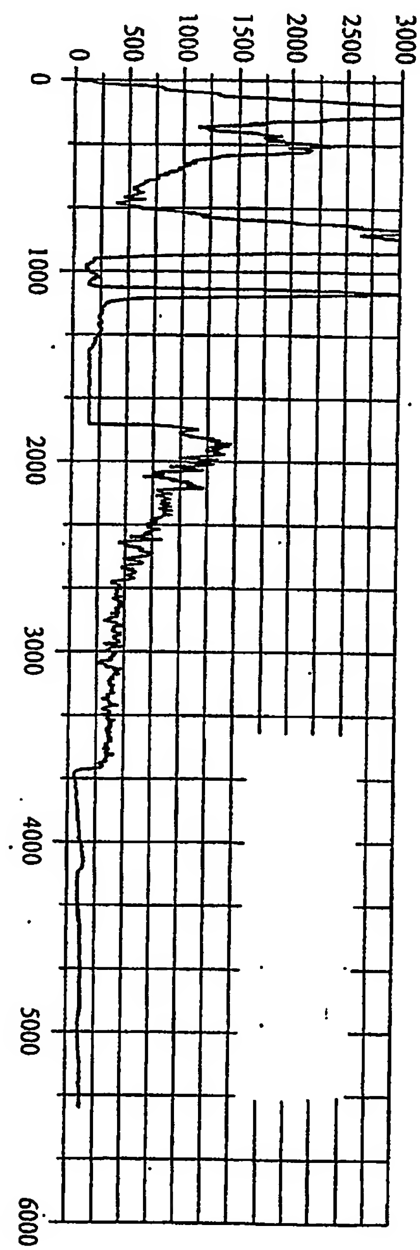


Fig. 3b